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power equipment without moving parts SUB-CYCLE® CONVERTERS AND FLOTROL RECTIFIERS

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NOTE

PROGRAMMED PREVENTIVE MAINTENANCE Is Available On This And Other Lorain Products Manufactured Equipment. For Further Information, Contact "Service Manager" At The Above Address.

LORAIN MODEL CST5
D-C TO D-C CONVERTER

Spec No. 5664-014 Serial No. _____

INSTRUCTIONS
LORAIN MODEL CST5 D-C TO D-C CONVERTERS
SD-5664-012 AND SD-5664-014

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INSTRUCTIONS
LORAIN MODEL CST5 D-C TO D-C CONVERTERS
SD-5664-012 AND SD-5664-014

1. RATINGS

Input: 44 to 52 volt d-c; 19 amperes

Model CST5, Spec No. 5664-012, is equipped for use in a system with the negative input grounded.

Model CST5, Spec No. 5664-014, is equipped for use in a system with the positive input grounded.

Output: nominal 130 volt d-c, adjustable 120 volt to 140 volt; 5 amperes

2. DESCRIPTION

LORAIN Model CST5 D-c to D-c Converter supplies nominal 130 volt d-c, suitable to operate a carrier, repeater, or telegraph system, from nominal 50 volt battery input. Since d-c output is transformer-isolated from d-c input, either positive or negative output can be grounded or both positive and negative output can be left ungrounded, regardless of input ground polarity. Both d-c input and d-c output circuits are filtered to limit transmission of noise to either input battery or 130 volt d-c load.

D-c output voltage is regulated within plus-or-minus 1% at any output current between zero and rated output current of 5 amperes, despite variation of input d-c voltage between 44 volts to 52 volts. D-c output voltage and output current are indicated by a voltmeter and an ammeter.

Two or more LORAIN Model CST5 D-c to D-c Converters can be connected in parallel to supply additional current to 130 volt d-c load current. Each unit is self-protected against overload; in event of overload, d-c output voltage will decrease as necessary to limit output current to a safe value.

3. INSTALLATION

a. Mounting

LORAIN Model CST5 D-c to D-c Converter can be mounted in a nineteen inch relay rack. It requires 8-3/4 inches panel space, extends 5 inches to front of rack, and has overall depth of 13-7/8 inches.

CAUTION: In mounted position, vent openings at top and bottom of the D-c to D-c Converter must be unobstructed. This is necessary for proper cooling during operation. When mounting this unit in a relay rack above other heat producing equipment, it is recommended

that a minimum ventilation space of 5-1/4 inches be provided both above and below the cabinet and an accessory baffle plate (L. P. C. Part No. 4133-021) be installed in the ventilation space below the unit. The temperature of the air entering the cabinet should not exceed 50°C.

b. Electrical Lead Entrance

To gain access to installer connection terminals, release two twist-type fasteners and remove rear cover from D-c to D-c Converter. Input, output, and alarm lead entrance is by means of an insulator bushing, in left hand rear cover bracket as viewed from rear of D-c to D-c Converter, to adjacent input-output terminal block and alarm terminal strip. This bushing has two sections, which are threaded together; if desired, it can be replaced with a standard one inch conduit fitting.

c. Electrical Connections

CAUTION: Before making electrical connections, be certain that input circuit breaker CB1 has been thrown to OFF position.

(1) Connect 130 volt d-c load at output terminals 3 (positive) and 4 (negative). If necessary, remove and reverse selector plug above installer terminals; with designation +130 upright, output fuse F2, output diode CR21, and output ammeter are in series with positive output for use in a positive (negative-ground) system; with designation -130 upright, F2, CR21, and ammeter are in series with negative output for use in a negative (positive-ground) system.

(2) Supply nominal 50 volt d-c at input terminals 1 (negative) and 2 (positive).

CAUTION: Connect d-c input terminals directly to battery; do not connect any filter between battery and D-c to D-c Converter input, as an input filter may cause voltage peaks which would damage transistors.

(3) To cause alarm indicator lamp to light in event of d-c output failure, supply nominal 50 volt positive battery (negative battery for Spec No. 5664-014) at terminal 11 of alarm terminal strip. Alarm terminals 5 and 6 furnish negative 50 volt ground (positive 50 volt ground for Spec No. 5664-014), while terminals 7 to 8 and terminals 9 to 10 each supply a closed loop, to give an external alarm. Closed-loop alarm terminals in each of two or parallel-connected units can be connected in series to give a major alarm.

4. ADJUSTMENT

a. General

To gain access to all user adjustments, release two twist-type fasteners and remove front cover from LORAIN D-c to D-c Converter.

b. D-c Output Voltage

Potentiometer R24 sets d-c output voltage to any value between 120 volts and 140 volts. To increase output voltage, turn screwdriver adjustment shaft of R24 clockwise; to decrease output voltage, turn shaft counterclockwise.

c. Manufacturer Adjustments

Special manufacturer adjustments are made on each LORAIN Model CST5 D-c to D-c Converter. It is recommended that no change be made in these adjustment settings:

(1) Resistor R23 is adjusted to establish range over which potentiometer R24 will set d-c output voltage.

(2) Setting of resistor R19 determines amount of d-c bias current supplied to magnetic amplifier T5. With a short-circuit applied across d-c output terminals, R19 is adjusted so that d-c output current will be between 2 amperes and 3 amperes.

(3) Potentiometer R32 adjusts value of output current at which an output current limiter will begin to reduce d-c output voltage. Factory setting of this adjustment will allow D-c to D-c Converter to deliver output voltage to which it is adjusted at rated output current of 5 amperes, but will prevent increase of output current beyond approximately 6 amperes.

5. OPERATION

a. Starting and Stopping

To turn LORAIN D-c to D-c Converter on or off, throw toggle of input circuit breaker CB1 to ON position or OFF position.

b. Metering

D-c output voltage and output current are indicated by a voltmeter and an ammeter.

c. Alarm Indication

In event of d-c output failure, lamp AIARM lights, and an external output failure alarm is given.

5. d. Fuses

Fuse F1 protects d-c input in event of short-circuit in either capacitor of input capacitor bank C1. Fuse F2 can be connected in series with either positive or negative d-c output (user option), as necessary to cause it to protect whichever side of d-c output is ungrounded. Since this D-c to D-c Converter is self-protected against overload, an overload condition will not cause either fuse, or input circuit breaker CB1, to open.

Output fuse F2 is carried in a bayonet-type fuseholder which is accessible at front of D-c to D-c Converter when front cover is installed. To gain access to input fuse F1, release two twist-type fasteners and remove back cover from D-c to D-c Converter. If necessary to replace either fuse, replace only with fuse type and size as follows, or equivalent:

Input fuse F1: Bussmann Type BAF cartridge, 25 ampere
Output fuse F2: Bussmann Type MTH cartridge, 6 ampere

If circuit breaker CB1 should open, this will be reflected by movement of its toggle from ON position to OFF position. In general, if circuit breaker CB1 opens, this indicates failure of some component. To reset, throw CB1 toggle to ON position.

6. CIRCUIT DESCRIPTION

a. General

This LORAIN D-c to D-c Converter includes an inverter (oscillators and power amplifier) which changes 50 volt d-c input to alternating current, a power transformer which steps up inverter output voltage, and a power rectifier which changes a-c to 130 volt d-c.

An output voltage regulator, actuated by a voltage-sensing network connected across d-c output, supplies control current to a magnetic amplifier which then causes effective inverter output voltage to vary as necessary to correct against any variation of d-c output voltage.

As d-c output current increases, voltage developed across a resistor in series with d-c output also increases; when d-c output current increases beyond its rated maximum value, this voltage causes an output current limiter to decrease magnetic amplifier control current and prevent further increase of d-c output current.

b. Input Circuit

Input fuse F1 opens to break d-c input in event of short-circuit in either capacitor of input capacitor bank C1. Input circuit breaker CB1 opens to break d-c input if any other failure causes excessive input current.

6. b. (continued)

Choke L1 and capacitor bank C1 form an input filter which limits transmission of noise to input battery. Diode CR1, connected across L1, clamps transistor collector supply voltage to d-c input voltage, to prevent damage to transistors from excessive forward voltage peaks.

c. Master Oscillator

Input d-c is connected across a series circuit made up of emitter and collector of transistor Q5, and emitter and collector of transistor Q6. Initially, either Q5 or Q6 will assume dominance and conduct; assume that Q5 conducts to start oscillation.

Current flows from positive input through Q5 emitter and collector, primary windings between terminals 5 to 6 and terminals 15 to 16 of master oscillator transformer T1, and capacitor C7 to negative input. Primary current in transformer T1 induces voltage in T1 feedback windings between terminals 7 to 8 and terminals 17 to 18; negative base-emitter voltage is supplied to Q5 to increase Q5 base current and drive Q5 to maximum conduction; positive base-emitter voltage is applied to Q6 to prevent flow of Q6 base current and drive Q6 to cutoff.

With Q5 at maximum conduction, d-c input voltage is applied almost entirely across T1 primary windings. After a brief interval, this causes T1 to become saturated. At this time, voltage developed across T1 primary windings decreases sharply and Q5 prevents further increase of T1 primary current; this causes T1 feedback voltage to decay so that T1 no longer furnishes base drive current to sustain conduction of Q5. When Q5 ceases to conduct, T1 primary current decays and causes polarity of T1 feedback voltage to reverse, so that Q6 is driven to maximum conduction and Q5 is driven to cutoff.

When Q6 conducts, current flows from positive input through capacitor C6, T1 primary windings between terminals 16 to 15 and terminals 6 to 5, and Q6 emitter and collector to negative input. A portion of Q6 collector current also flows to C7, to partially discharge C7. Note that direction of T1 primary current has now reversed; this current continues to induce feedback voltage which maintains Q6 at maximum conduction and Q5 at cutoff. Again, after a brief interval, T1 becomes saturated, causing T1 primary voltage to decrease sharply, at which time Q6 limits primary current to cause another similar reversal. This cycle is repeated approximately 500 times per second; it causes square-wave current to flow between junction of capacitors C6-C7 and junction of Q5 collector-Q6 emitter through T1 primary windings.

Resistors R9 and R10 limit Q5 and Q6 base drive current. Capacitors C2 and C3 furnish low-impedance paths to drive current transients to improve switching characteristics of Q5 and Q6. Diodes CR2 and CR3 protect Q5 and

6. c. (continued)

Q6 against inverse collector-emitter voltage. After initial charge has been applied to capacitors C6 and C7, these capacitors alternately increase and decrease charge on alternate oscillator half-cycles, as necessary to maintain collector supply voltage to each of transistors Q5 and Q6 at one-half of d-c input voltage.

d. Slave Oscillator

Emitter and collector of transistor Q7, and emitter and collector of transistor Q8 are also connected in series across d-c input.

Square-wave voltage developed between transistor Q5 collector-Q6 emitter junction and capacitor C6-C7 junction is applied to a series circuit made up of outer-leg gate windings of magnetic amplifier T5, described below, and primary windings between terminals 1 to 2 and terminals 5 to 6 of feedback transformer T2. Magnetic amplifier T5 transmits a trigger pulse to transformer T2 at some instant during each master oscillator half-cycle.

Trigger pulses supplied through T5 to T2 are in alternate directions on alternate master oscillator half-cycles, this resulting T2 primary current induces voltage peaks in alternate directions in T2 feedback windings between terminals 3 to 4 and terminals 7 to 8. During master oscillator half-cycles in which transistor Q5 conducts, T2 supplies a negative base-emitter voltage pulse to transistor Q7 to cause Q7 base current to flow and drive Q7 to conduction, and furnishes a positive base-emitter voltage pulse to transistor Q8 to prevent flow of Q8 base current and drive Q8 to cutoff. During alternate master oscillator half-cycles when transistor Q6 conducts, voltage pulse polarities induced in T2 feedback windings are reversed so that Q8 is driven to conduction and Q7 is driven to cutoff. These voltage pulses serve as a trigger, to cause keyed oscillation of Q7 and Q8.

When Q7 conducts, current flows from positive input through Q7 emitter and collector, primary windings between terminals 12 to 11 and terminals 6 to 5 of slave oscillator output transformer T3 and capacitor C7 to negative input. When Q8 conducts, current flows from positive input through capacitor C6, T3 primary windings between terminals 5 to 6 and terminals 11 to 12, and Q8 emitter and collector to negative input. Note that direction of T3 primary current reverses on alternate half-cycles.

Primary voltage of output transformer T3 is supplied through feedback resistor R13 to primary windings of feedback transformer T2. This voltage maintains T2 primary current throughout each half-cycle and sustains drive voltages supplied by T2 feedback windings to Q7 and Q8, hence it causes Q7 and Q8 to produce a square wave.

6. d. (continued)

Resistors R11 and R12 limit Q7 and Q8 base drive current. Capacitors C4 and C5 furnish low-impedance paths to drive current transients to improve switching characteristics of Q7 and Q8. Diodes CR4 and CR5 protect Q7 and Q8 against inverse collector-emitter voltage. Transistor Q7 and Q8 collector current also alternately increases and decreases charge of capacitors C6 and C7, as necessary to maintain Q7 and Q8 collector supply voltage at one-half of d-c input voltage.

e. Power Amplifier

Transistors Q1A through Q4B are connected as a bridge-type power amplifier. Secondary windings of master oscillator transformer T1 drive Q1A, Q1B, Q4A, and Q4B, which form two legs of this amplifier bridge, while secondary windings of slave oscillator output transformer T3 drive Q2A, Q2B, Q3A, and Q3B which form two additional legs.

This power amplifier is driven to large-signal (switching) operation; odd-numbered transistors are driven to maximum conduction while even-numbered transistors are driven to cutoff then, during alternate half-cycles, even-numbered transistors are driven to maximum conduction while odd-numbered transistors are driven to cutoff.

During half-cycles in which odd-numbered transistors conduct, current flows from positive input through resistors R1A and R1B, Q1A and Q1B emitters and collectors, primary winding between terminals 3 to 4 of power transformer T4, resistors R3A and R3B, Q3A and Q3B emitters and collectors, and contacts of relay K3 to negative input. During alternate half-cycles, current flows from positive input through resistors R2A and R2B, Q2A and Q2B emitters and collectors, T4 primary between terminals 4 to 3, resistors R4A, R4B and Q4A and Q4B emitters and collectors, and contacts of relay K3 to negative input. Thus, transistors Q1A through Q4B switch d-c input in alternate directions to furnish alternating current to power transformer T4.

Base resistors R14 through R17 limit transistor base drive current. Emitter resistors R1A through R4B are degenerative, to compensate against any difference of gain in parallel-connected transistors. Diodes CR10 through CR13 protect Q1A through Q4B against inverse collector-emitter voltage. Resistance-capacitance-diode networks R5-C8-CR6, R6-C9-CR7, R7-C10-CR8, and R8-C11-CR9 absorb switching transients to reduce power dissipation in Q1A through Q4B. Initially, input d-c is supplied through resistor R47 and contacts of relay K3, released, to charge capacitor C18; when C18 has become charged, relay K3 operates and contacts of relay K3, operated, connect resistor R48 to discharge C18. Resistor R46 decreases collector supply voltage of Q1A through Q4B until relay K3 has operated, as necessary to assure that both master oscillator and slave oscillator will be in normal operation before full power amplifier collector voltage is applied.

6. f. D-c Power Circuit

Power transformer T4 is a stepup transformer which increases inverter output voltage to higher a-c voltage required by a power rectifier made up of diodes CR14 through CR17. This bridge-type rectifier changes alternating current supplied by T4 to direct current, which is then supplied to 130 volt d-c load.

Output fuse F2, diode CR21, and an output ammeter can be connected in series with positive output if negative 130 volt load is grounded, or in series with negative output if positive 130 volt load is grounded. These options are selected by means of a reversible plug.

Output diode CR21 conducts to permit current to flow from this D-c to D-c Converter to d-c load but, in event of output failure, blocks to prevent flow of output current from any parallel-connected D-c to D-c Converter through output of this unit. Thus, diode CR21 assures that an output failure alarm will be given.

Chokes L2 and L3, in series with negative output, and capacitor C13 with capacitor bank C14, across d-c output, form an output filter which smooths a-c ripple from output of diodes CR14 through CR17 so that D-c to D-c Converter output will more nearly approach pure d-c. Resistance-capacitance network R21-C12 protects CR14 through CR17 against voltage peaks.

g. Magnetic Amplifier T5

Magnetic amplifier T5 is controlled by an output voltage regulator and an output current limiter, described below, to cause increase or decrease of effective a-c voltage supplied to power transformer T4. This maintains constant d-c output voltage and prevents increase of output current beyond a safe value.

Magnetic amplifier T5 has a three-legged core which carries two gate windings, one on each of its two outer legs, and one bias winding and one control winding on its center leg.

As noted above, square-wave voltage developed between capacitor C6-C7 junction, and junction of master oscillator transistor Q5 collector-Q6 emitter is applied to a series circuit which consists of T5 gate windings and primary windings of feedback transformer T2. Each time square-wave voltage changes polarity (start of each master oscillator half-cycle), T5 is initially unsaturated and this voltage appears almost entirely across T5 gate windings. Gate winding current then increases slowly until T5 becomes saturated, at which time gate winding voltage decreases sharply and T5 transmits a trigger pulse to T2.

6. g. (continued)

Bias current flows from positive d-c input through a T5 winding between terminals 8 to 7, and resistors R19 and R20 to negative input. This current aids saturation of T5 by gate winding current. Resistor R19 is adjusted so that, with only gate winding current and bias current supplied to T5, T5 will remain unsaturated until each master oscillator half-cycle has been nearly completed.

Control current flows through a T5 winding between terminals 6 to 5. This current aids bias current; when it increases, it causes T5 to become saturated earlier during each master oscillator half-cycle and, when it decreases, it causes T5 to remain unsaturated for a greater portion of each half-cycle.

h. Output Voltage Regulator

During each master oscillator half-cycle, when magnetic amplifier T5 transmits a trigger pulse to feedback transformer T2, T5 initiates a polarity change (start of a half-cycle) at slave oscillator output. When T5 remains unsaturated during almost a complete master oscillator half-cycle, it delays this trigger pulse and causes slave oscillator output to be almost completely out of phase with master oscillator output. As control current increases, however, T5 becomes saturated earlier during each master oscillator half-cycle so that resulting earlier trigger pulses cause slave oscillator output to become more nearly in phase with master oscillator output.

As noted above, transistors Q1A, Q1B, Q4A, and Q4B are driven by master oscillator output, while transistors Q2A, Q2B, Q3A, and Q3B are driven by slave oscillator output. When master oscillator output has driven Q1A and Q1B to conduction, current cannot flow to power transformer T4 until slave oscillator output has driven Q3A and Q3B to conduction. Likewise, when master oscillator output has driven Q4A and Q4B to conduction, current cannot flow to T4 until slave oscillator output has driven Q2A and Q2B to conduction.

When T5 control current increases and causes T5 to shift slave oscillator output more nearly in phase with master oscillator output, it causes T4 primary current to flow for a greater portion of each master oscillator half-cycle. This increases effective T4 primary voltage. Similarly, when T5 control current decreases and causes T5 to shift slave oscillator output farther out of phase with master oscillator output, it decreases portion of each master oscillator half-cycle during which T4 primary current flows. This decreases effective T1 primary voltage.

Resistances R23, R24, R43, and R25 are connected in series across 130 volt d-c output so that voltage developed across resistor R23 and adjacent portion of potentiometer R24 is proportional to d-c output voltage. This

R23-R24 voltage is applied across zener diode CR18 and emitter to base of transistor Q11, causing Q11 base current to flow, so that Q11 is driven to conduction. When Q11 conducts, current flows from positive d-c output through CR18, Q11 emitter and collector, and resistors R27 and R28 to negative d-c output.

Note that zener diode CR18 conducts in reverse direction. Characteristics of CR18 are such that, once this occurs, essentially constant voltage will appear across CR18 while any increase or decrease of d-c output voltage will appear across other circuit elements. Constant voltage developed across CR18 holds Q11 emitter potential constant with respect to positive d-c output. Potentiometer R24 is adjusted so that R23-R24 voltage will slightly exceed constant CR18 voltage, to maintain negative base-emitter potential supplied to Q11, so that Q11 will continue to conduct.

Constant CR18 voltage, plus voltage developed across Q11 emitter and collector, is applied across resistor R29 and emitter to base of transistor Q10. This voltage causes Q10 base current to flow and drives Q10 to conduction. Transistor Q10 collector current flows from positive d-c output through R29, Q10 emitter and collector, control winding between terminals 6 to 5 of magnetic amplifier T5, and resistor R28 to negative d-c output, as necessary to cause voltage developed across R29 to approach CR18-plus-Q11 emitter-collector voltage.

If d-c output voltage decreases, R23-R24 voltage also decreases. This reduces negative base-emitter potential supplied to Q11, decreases Q11 base current, and reduces conduction of Q11 to increase Q11 emitter-collector voltage. Increased Q11 emitter-collector voltage causes Q10 base-emitter voltage to increase, increasing Q10 base current, to drive Q10 to greater conduction. Collector current, supplied by Q10 as control current to T5, then increases until R29 voltage again approaches CR18-plus-Q11 emitter-collector voltage. Increased control current causes T5 to increase effective a-c voltage furnished to power transformer T4 and increase d-c output voltage.

Similarly, if d-c output voltage increases, conduction of Q11 increases, conduction of Q10 decreases, and reduced T5 control current causes T5 to decrease d-c output voltage.

Resistance-capacitance network R26-C15 prevents abrupt changes of Q11 collector current to avert a hunting condition (oscillation of d-c output voltage or output current).

i. Output Current Limiter

Resistor R22 is connected in series with positive d-c output, so that voltage developed across R22 will increase or decrease in accordance with increase or decrease of d-c output current. This voltage is applied across potentiometer R32 and emitter to base of transistor Q9, causing Q9 base current to flow, to drive Q9 to conduction.

6. i. (continued)

In usual operation, dynamic resistance of R32-plus-Q9 emitter-collector is sufficiently high that CR18-plus-Q11 emitter-collector voltage prevents flow of Q9 collector current. Potentiometer R32 is adjusted so that, when d-c output current increases beyond its rated value, this dynamic resistance will decrease sufficiently to cause current to flow from positive d-c output (ahead of R22) through R32, Q9 emitter and collector, and resistors R27 and R28 to negative d-c output.

When Q9 collector current flows, voltage developed across R27 and R28 prevents further increase of CR18-plus-Q11 emitter-collector voltage, hence drive voltage supplied across Q10 base-emitter and R29 is limited. Successively, this prevents further increase of Q10 base current and Q10 collector current supplied as control current to T5. With T5 control current held at a maximum value, T5 prevents further increase of effective a-c voltage furnished to T4. This limits d-c output current to a safe value.

LORAIN PRODUCTS CORPORATION
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LORAIN PRODUCTS (CANADA) LTD.
St. Thomas, Ontario, Canada

December 2, 1970

ELECTRICAL PARTS LIST
LORAIN MODEL CST5 DC TO DC CONVERTER
SPEC. NO. 5664-014

This Electrical Parts List is arranged alphabetically by part name. Spare parts are not usually required if adequate standby equipment is available and if the LORAIN EQUIPMENT is installed at an accessible location so that parts can readily be obtained from Lorain Products stock. When ordering parts, please furnish equipment Model No., Spec. No., and Serial No. as given on the equipment nameplate. The quantity of spare parts listed should be sufficient for ten or less assemblies or models for at least 18 months. If a single asterisk (*) appears in the Quantity Recm. Spares column, it indicates the part, assembly, or model is listed more than once, in which case, use the quantity where the item first appears. If two asterisks (**) appear, refer to the sub-list for that assembly or model. If a dash (-) appears, this indicates that spares are not recommended for this part or assembly.

Ref. Desig.	LPC Part No.	Description	Quantity Recm. Spares
ASSEMBLIES			
	4337-025	Reference PC Board	1
	4732-003	Heat Sink	**
	4827-043	Transistor and Heat Sink	**
	4844-004	Input Control	**
CAPACITORS			
C1	2731-318	6600UF 75 Volt, Electrolytic	-
C2	2715-273	1UF 200 Volt	1
C3	2715-273	1UF 200 Volt	*
C4	2715-273	1UF 200 Volt	*
C5	2715-273	1UF 200 Volt	*
C6	2731-172	300UF 50 Volt, Electrolytic	-
C7	2731-172	300UF 50 Volt, Electrolytic	-
C12	2713-444	0.1UF 600 Volt	1
C13	2731-670	290UF 200 Volt, Electrolytic	-
C14	2731-772	2500UF 200 Volt, Electrolytic	-
C15	2715-145	5UF 150 Volt	1
CIRCUIT BREAKERS			
CB1	2566-115	25 Amp 50 Volt DC	1
DIODES			
CR1	2812-521	1N4721, Silicon	1
CR2	2812-310	1N4818, Silicon	2
CR3	2812-310	1N4818, Silicon	*
CR4	2812-310	1N4818, Silicon	*
CR5	2812-310	1N4818, Silicon	*
CR21	2813-144	1N1202A, Silicon	1

ELECTRICAL PARTS LIST
LORAIN MODEL CST5 DC TO DC CONVERTER
SPEC. NO. 5664-014

Ref. Desig.	LPC Part No.	Description	Quantity Recm. Spares
FUSES			
F1	2483-442	25 Amp, Cartridge	3
F2	2483-244	6 Amp, Cartridge	3
INDICATOR LAMPS			
DS1	2581-125	48 Volt, Filament	1
INDUCTORS			
L1	4414-507	Filter	-
L2	4422-010	Output Filter	-
L3	4415-001	Input	-
L4	4411-545	RF	-
METERS			
M1	2943-213	0-150 Voltmeter, DC	-
M2	2923-206	0-10 Ammeter, DC	-
RELAYS			
K1	2542-911	130 Volt, Telephone	1
RESISTORS			
R9	2651-305	3 Ohm 3 Watt, Fixed	1
R10	2651-305	3 Ohm 3 Watt, Fixed	*
R11	2651-305	3 Ohm 3 Watt, Fixed	*
R12	2651-305	3 Ohm 3 Watt, Fixed	*
R13	2662-432	51 Ohm 2 Watt, Fixed	1
R16	2652-601	0.5 Ohm 20 Watt	1
R19	2681-425	1500 Ohm 10 Watt, Adjustable	1
R20	2652-329	500 Ohm 10 Watt, Fixed	1
R21	2652-319	100 Ohm 10 Watt, Fixed	1
R22	2656-501	1 Ohm 25 Watt, Fixed	1
R23	2681-414	200 Ohm 10 Watt, Adjustable	1
R24	2683-235	50 Ohm 2 Watt, Variable	1
R25	2652-341	2000 Ohm 10 Watt, Fixed	1
R26	2662-815	10 Ohm 2 Watt, Fixed	1
R28	2652-344	3000 Ohm 10 Watt, Fixed	1
R32	2683-248	250 Ohm 2 Watt, Variable	1
R33	2652-348	5000 Ohm 10 Watt, Fixed	1

ELECTRICAL PARTS LIST
LORAIN MODEL CST5 DC TO DC CONVERTER
SPEC. NO. 5664-014

Ref. Desig.	LPC Part No.	Description	Quantity Recm. Spares
RESISTORS (Cont'd)			
R34	2651-754	10,000 Ohm 5 Watt, Fixed	1
R43	2664-607	1000 Ohm 5 Watt, Fixed	1
R44	2652-344	3000 Ohm 10 Watt, Fixed	1
R51	2662-777	0.27 Ohm 2 Watt, Fixed	1
R52	2662-777	0.27 Ohm 2 Watt, Fixed	*
R53	2662-777	0.27 Ohm 2 Watt, Fixed	*
R54	2662-777	0.27 Ohm 2 Watt, Fixed	*
TRANSFORMERS			
T1	4516-001	Oscillator	-
T2	4511-603	Feedback	-
T3	4513-001	Oscillator	-
T4	4511-605	Power	-
T5	4544-507	Transductor	-
TRANSISTORS			
Q5	2848-061	2N1536A	2
Q6	2848-061	2N1536A	*
Q7	2848-061	2N1536A	*
Q8	2848-061	2N1536A	*
MISCELLANEOUS			
	2488-106	Fuseholder	1
	2488-256	Fuse Block	1
	2584-113	Lampholder	1
	2584-636	Cap, Lens, Red	1

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ELECTRICAL PARTS LIST
LORAIN 4732-003 HEAT SINK ASSEMBLY

This Electrical Parts List is arranged alphabetically by part name. Spare parts are not usually required if adequate standby equipment is available and if the LORAIN EQUIPMENT is installed at an accessible location so that parts can readily be obtained from Lorain Products stock. When ordering parts, please furnish equipment Model No., Spec. No., and Serial No. as given on the equipment nameplate. The quantity of spare parts listed should be sufficient for ten or less assemblies or models for at least 18 months. If a single asterisk (*) appears in the Quantity Recm. Spares column, it indicates the part, assembly, or model is listed more than once, in which case, use the quantity where the item first appears. If two asterisks (**) appear, refer to the sub-list for that assembly or model. If a dash (-) appears, this indicates that spares are not recommended for this part or assembly.

Ref. Desig.	LPC Part No.	Description	Quantity Recm. Spares
DIODES			
CR14	2813-142	1N1203RA, Silicon	1
CR15	2813-142	1N1203RA, Silicon	*
CR16	2813-141	1N1203A, Silicon	1
CR17	2813-141	1N1203A, Silicon	*

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ELECTRICAL PARTS LIST
LORAIN 4827-043 TRANSISTOR AND HEAT SINK ASSEMBLY

This Electrical Parts List is arranged alphabetically by part name. Spare parts are not usually required if adequate standby equipment is available and if the LORAIN EQUIPMENT is installed at an accessible location so that parts can readily be obtained from Lorain Products stock. When ordering parts, please furnish equipment Model No., Spec. No., and Serial No. as given on the equipment nameplate. The quantity of spare parts listed should be sufficient for ten or less assemblies or models for at least 18 months. If a single asterisk (*) appears in the Quantity Recm. Spares column, it indicates the part, assembly, or model is listed more than once, in which case, use the quantity where the item first appears. If two asterisks (**) appear, refer to the sub-list for that assembly or model. If a dash (-) appears, this indicates that spares are not recommended for this part or assembly.

Ref. Desig.	LPC Part No.	Description	Quantity Recm. Spares
CAPACITORS			
C8	2715-158	10UF 150 Volt	1
C9	2715-145	5UF 150 Volt	1
C10	2715-145	5UF 150 Volt	*
C11	2715-158	10UF 150 Volt	*
DIODES			
CR6	2812-225	1N1221, Silicon	2
CR7	2812-225	1N1221, Silicon	*
CR8	2812-225	1N1221, Silicon	*
CR9	2812-225	1N1221, Silicon	*
CR10	2812-215	1N1218, Silicon	2
CR11	2812-215	1N1218, Silicon	*
CR12	2812-215	1N1218, Silicon	*
CR13	2812-215	1N1218, Silicon	*
RESISTORS			
R1A	3151-710	Wire Copel	1
R1B	3151-710	Wire Copel	*
R2A	3151-710	Wire Copel	*
R2B	3151-710	Wire Copel	*
R3A	3151-710	Wire Copel	*
R3B	3151-710	Wire Copel	*
R4A	3151-710	Wire Copel	*
R4B	3151-710	Wire Copel	*
R5	2651-715	35 Ohm 5 Watt, Fixed	1
R6	2651-715	35 Ohm 5 Watt, Fixed	*
R7	2651-715	35 Ohm 5 Watt, Fixed	*
R8	2651-715	35 Ohm 5 Watt, Fixed	*

ELECTRICAL PARTS LIST
LORAIN 4827-043 TRANSISTOR AND HEAT SINK ASSEMBLY

Ref. Desig.	LPC Part No.	Description	Quantity Recm. Spares
TRANSISTORS			
Q1A	2848-150	15 Amp, PNP, Germanium	4
Q1B	2848-150	15 Amp, PNP, Germanium	*
Q2A	2848-150	15 Amp, PNP, Germanium	*
Q2B	2848-150	15 Amp, PNP, Germanium	*
Q3A	2848-150	15 Amp, PNP, Germanium	*
Q3B	2848-150	15 Amp, PNP, Germanium	*
Q4A	2848-150	15 Amp, PNP, Germanium	*
Q4B	2848-150	15 Amp, PNP, Germanium	*

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ELECTRICAL PARTS LIST
LORAIN 4844-004 INPUT CONTROL ASSEMBLY

This Electrical Parts List is arranged alphabetically by part name. Spare parts are not usually required if adequate standby equipment is available and if the LORAIN EQUIPMENT is installed at an accessible location so that parts can readily be obtained from Lorain Products stock. When ordering parts, please furnish equipment Model No., Spec. No., and Serial No. as given on the equipment nameplate. The quantity of spare parts listed should be sufficient for ten or less assemblies or models for at least 18 months. If a single asterisk (*) appears in the Quantity Recm. Spares column, it indicates the part, assembly, or model is listed more than once, in which case, use the quantity where the item first appears. If two asterisks (**) appear, refer to the sub-list for that assembly or model. If a dash (-) appears, this indicates that spares are not recommended for this part or assembly.

Ref. Desig.	LPC Part No.	Description	Quantity Recm. Spares
ASSEMBLIES			
K3	4844-010	50 Amp Contactor	**
CAPACITORS			
C18	2731-172	300UF 50 Volt, Electrolytic	-
RESISTORS			
R14	2652-601	0.5 Ohm 20 Watt, Fixed	1
R15	2652-601	0.5 Ohm 20 Watt, Fixed	*
R17	2652-601	0.5 Ohm 20 Watt, Fixed	*
R46	2656-503	3 Ohm 25 Watt, Fixed	1
R47	2651-721	150 Ohm 5 Watt, Fixed	1
R48	2662-823	22 Ohm 2 Watt, Fixed	1

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ELECTRICAL PARTS LIST
LORAIN 4844-010 CONTACTOR ASSEMBLY

This Electrical Parts List is arranged alphabetically by part name. Spare parts are not usually required if adequate standby equipment is available and if the Lorain Equipment is installed at an accessible location so that parts can readily be obtained from Lorain Products stock. When ordering parts, please furnish equipment Model No., Spec No., and Serial No. as given on the equipment nameplate. The quantity of spare parts listed should be sufficient for ten or less assemblies or models for at least 18 months. If a single asterisk (*) appears in the Quantity Recm Spares column, it indicates the part, assembly or model is listed more than once, in which case, use the quantity where the item first appears. If two asterisks (**) appear, refer to the sub-list for that assembly or model. If a dash (-) appears, this indicates that spares are not recommended for this part or assembly.

Ref Desig	LPC Part No.	Description	Quantity Recm Spares
CONTACTORS			
	2561-015	50V 50A DC	1
SWITCHES			
	2532-206	Micro SPDT	1

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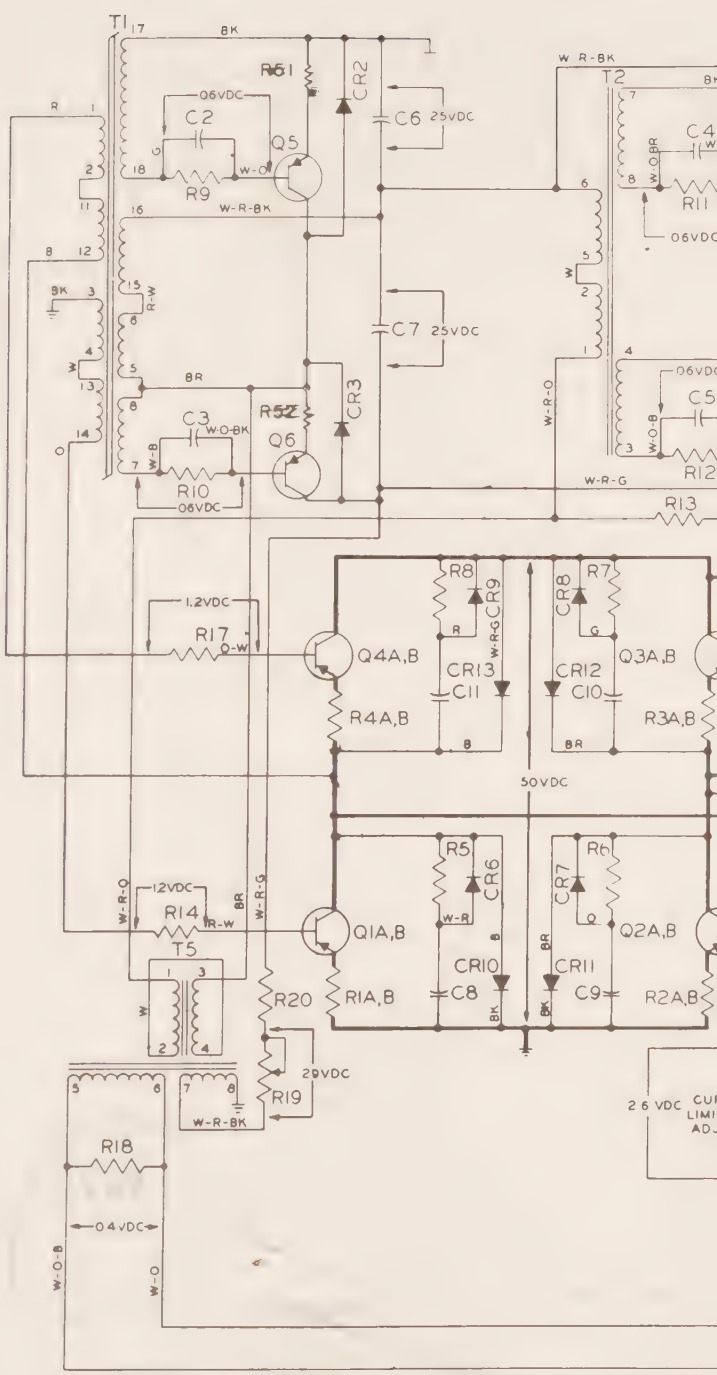


NOTES

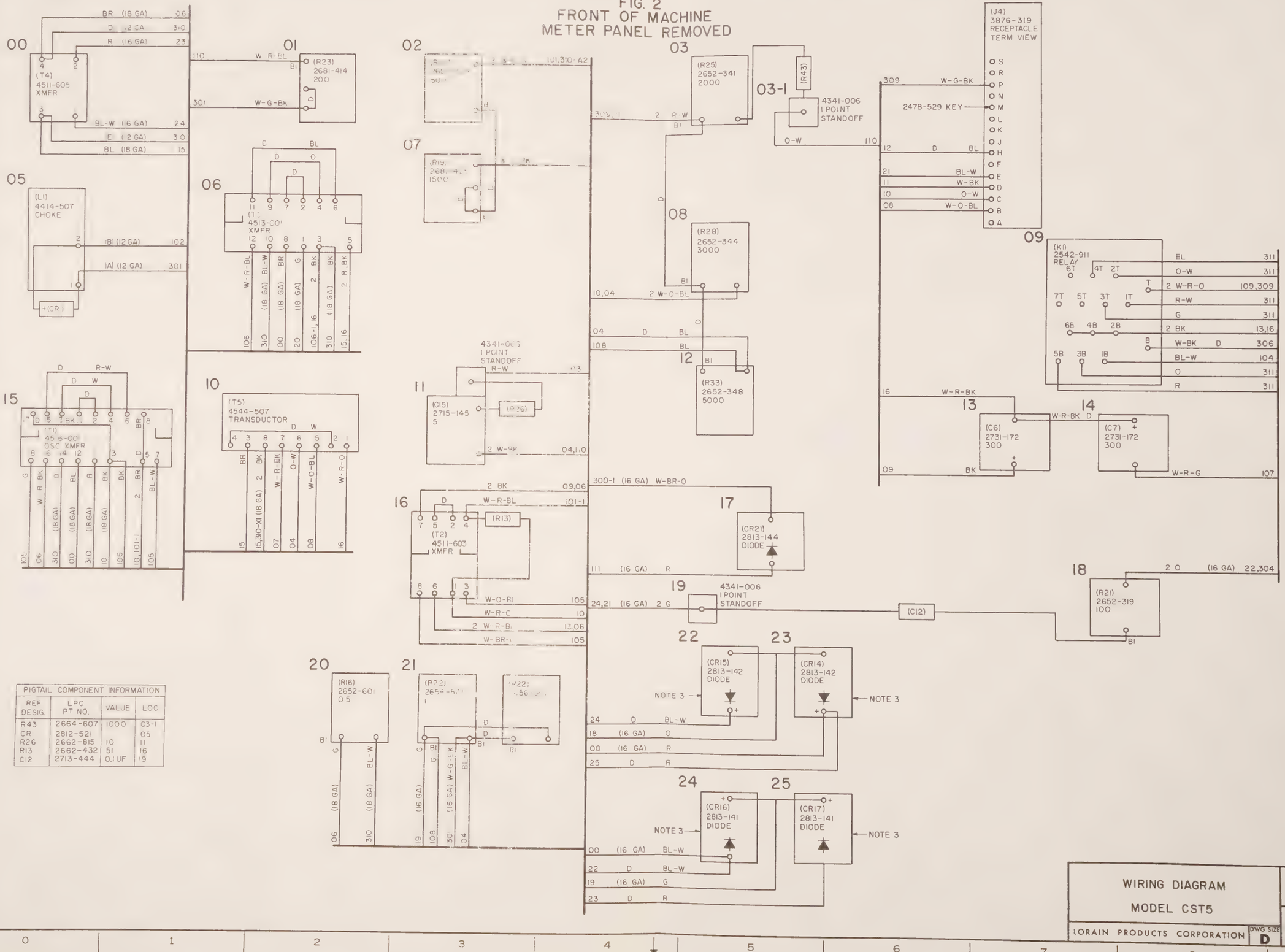
101 CONNECT INPUT TO BATTERY SIDE OF FILTER IN PLANTS HAVING DISCHARGE FILTER IN SERIES WITH LOAD

102 (S) OPTION CAN BE OBTAINED BY HAVING REVERSIBLE PLUG IN +130 POSITION.
(T) OPTION CAN BE OBTAINED BY HAVING REVERSIBLE PLUG IN -130 POSITION

103 TEST VOLTAGES: AC VOLTAGES MEASURED WITH 5000 OHM/VOLT, RECT TYPE AC VOLTMETER THRU 01 MFD DC BLOCKING CAPACITOR DC VOLTAGES MEASURED WITH 20,000 OHM/VOLT, DC VOLTMETER ALL READINGS ACCURATE WITHIN ±5%, NOMINAL INPUT VOLTAGE, NO LOAD OUTPUT

| SD-DRAWING ISSUES AND T-DRAWING ISSUES AS FOLLOWS | | |

FIG. 2
FRONT OF MACHINE
METER PANEL REMOVED



PIGTAIL COMPONENT INFORMATION			
REF DESIG.	LPC PT NO.	VALUE	LOC
R43	2664-607	1000	03-1
CR1	2812-521		05
R26	2662-815	10	11
R13	2662-432	51	16
C12	2713-444	0.1 UF	19

DRAWING ISSUE	
1	7 8-18-67
2	10-8-68
3	4-4-69
4	5-16-69
5	7-30-69
6	12-30-69
7	1-26-70
8	7-13-71
9	7-26-71

ISSUE 9

WIRING DIAGRAM MODEL CST5	T-5664-014
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00

(L3) 4415-001 OUTPUT CHOKE

0-W (16 GA) 01

2 R-W (16 GA) 01,09

00-1

09 PT

217 (16 GA) W-BR-O

(L4) 4411-545 FILTER CHOKE

01

4252-604 CAPACITOR BANK ASSEMBLY

01,09 (16 GA) 2 W-G-BK — (C14) + D (C14)

00 (16 GA) R-W — (C14) − D

01,221 (16 GA) 2 W-G-BK — (C13) +

201 W-G-BK

00,04 (16 GA) 2 O-W — (C13) −

04

(L2) 4422-010 OUTPUT CHOKE

0 (16 GA) 218

0-W (16 GA) 01

102 (12 GA) |B| — (C1) − (12 GA) D (C1)

06

(R34) 2651-754 10,000

W-BK D 209

10,18 (12 GA) 2|G| — + (12 GA) D

18 (12 GA) |H|

W-BR-BL 09 B1

205 (12 GA) |A| — (F1)

02

(C11) 2715-158 10

2 BL 08,10

R 08

(C8) 2715-158 10

2 BK 03,08

R-W 08

03

02,10 2 BK (C9) 2715-145 5

08 0

05

08,10 2 BR (C10) 2715-145 5

08 G

02 05 02

08

BK BR BL

(CR10-CR13) COMPONENT CARD SEE J-936-15 (CR6-CR9)

W-R-G 10

R-W O G R

02 03 05 02

09

BL (16 GA) 103 — 12

W-BK (16 GA) 103 — 10

PT 00-1 — 8

W-R-BK (16 GA) 18 — 6

W-R-O 209 — 4

R-W 203 — 2

R-W (16 GA) 00

(J) REVERSIBLE PLUG SOCKET

11 9 7 5 3 1

SEE DETAIL A

W-G-BK BK (16 GA) 01 204

2 W-BR-BL (16 GA) 109,06

W-R-BL (16 GA) 18

W-O-BK (16 GA) 111

10

4844-004

R-W (18 GA) 10 — 13

W-BK (18 GA) 10 — 16

BL-W (18 GA) 220 — 23

O-W (18 GA) 10 — 26

BK (18 GA) 10

BK (18 GA) 210

|F| (12 GA) 10

W-R-G 202

|C| (12 GA) 102

24,25 (12 GA) 2|F|

08 W-R-G

15,23 (12 GA) 2|D|

05 BR

02 BL

14,26 (12 GA) 2|E|

13,16 (12 GA) 2|+|

03 BK

10-XI (18 GA) BK

01 (12 GA) |G|

206 (18 GA) BK

200 (12 GA) |E|

200 (12 GA) |D|

10-AI (12 GA) |F|

A2 X2 AI XI

(R47) (K3)

CONNECT THESE WIRES TO UPPER STUD (C18)

(R46)

11

5 6 7 8 9 10 11

ALARM TB 3165-527 MARKER STRIP 2463-307 TERM. BLK

R O G BL R-W O-W G-W

209 209 209 209 209 209 104

18

(R44) 2652-344 3000

BK D 4 W-R-BK (16 GA) 09

BK D 3 W-R-BL (16 GA) 09

2 |G| (12 GA) 01

1 |H| (12 GA) 01

3166-702 MARKER STRIP 2462-313(5) CONT 2462-315(1) END

(R14) (R15) (R17)

R-W (18GA) 10 — 215

O (18GA) 215

W-BK (18GA) 10 — 206

BL-W (18GA) 206

O-W (18 GA) 10 — 215

R (18 GA) 215

12 NOTE 4

(Q1A) 2848-150 PWR TSTR

B C E

D (18 GA) 13 — |E| (12 GA) — D COPEL 14

23 D (18 GA) — |F| (12 GA) — COPEL D 24

(Q3A) 2848-150 PWR TSTR

NOTE 4

13

4341-401

R-W 2 — 10

(12 GA) |+| — 10

D COPEL 2 — 12,14

(18 GA) 2 D 22,24 — 10

BL-W

|D| (12 GA) — 10

COPEL 2D 22,24

4341-401

14 NOTE 4

(Q1B) 2848-150 PWR TSTR

B C E

D (18 GA) 13 — |E| (12 GA) 2 — D COPEL 13

10,12

23 D (18 GA) — |F| (12 GA) — COPEL D 24

22,10

2 |F|

(Q3B) 2848-150 PWR TSTR

NOTE 4

15 NOTE 4

(Q2A) 2848-150 PWR TSTR

B C E

D (18 GA) 16 — |D| (12 GA) 2 — D COPEL 16

10,17

26 D (18 GA) — |F| (12 GA) — COPEL D 25

27,10

2 |F|

(Q4A) 2848-150 PWR TSTR

16

4341-401

W-BK 2 — 10

(12 GA) |+| — 10

D COPEL 2 — 15,17

(18 GA) 2 D 25,27 — 10

O-W

|E| (12 GA) — 10

COPEL 2D 25,27

4341-401

NOTE 4

17 NOTE 4

(Q2B) 2848-150 PWR TSTR

B C E

D (18 GA) 16 — |D| (12 GA) 15 — D COPEL 16

26 D (18 GA) — |F| (12 GA) — COPEL D 26

(Q4B) 2848-150 PWR TSTR

DETAIL A

VIEW SHOWS WIRING SIDE OF PLUG

−130

2 4 6 8 10 12

1 3 5 7 9 11

+130

DRAWING ISSUE	
1	7-18-67
2	10-14-68
3	4-23-69
4	6-16-69
5	7-30-69
6	12-30-69
7	1-26-70
8	9-13-71
9	9-15-71

ISSUE G

WIRING DIAGRAM

MODEL CST5

T-5664-014

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SHEET 3 OF 3

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